CLAIMS

1. A method for growing a thin tungsten silicide film on a substrate in a reaction space, comprising:

(a) providing a hydrated substrate;

(b) introducing a tungsten halide precursor, where the halide is not fluorine, into the reaction space to the hydrated substrate to create, for example, a chlorine terminated substrate surface and deposit tungsten without scavenging silicon;

(c) introducing a silicon hydride precursor into the reaction space to the chloride terminated substrate surface to create a hydride terminated substrate surface and deposit silicon;

(d) repeating steps (b) and (c) an integral number of times to form a tungsten silicide film on the substrate, wherein a reaction by-product is a hydrogen halide.

2. The method of claim 1, wherein the temperature of the reaction space is maintained less than 600 °C.

3. The method of claim 1, further comprising:
providing an inert purge after each (b) and (c) step.

4. A method for growing a thin film on a substrate in a reaction space, comprising:

(a) providing a hydrated substrate;

(b) introducing a tungsten halide precursor, where the halide is not fluorine, into the reaction space to the hydrated substrate to create a halide terminated substrate surface;

(c) introducing a silicon precursor selected from $Si_nX_mY_kH_l$, where X and Y are halides and n,m,k,l are integers, into the reaction space to the halide terminated substrate surface to create a hydride terminated substrate surface;

(d) repeating steps (b) and (c) an integral number of times to form a metal silicide film on the substrate, wherein a reaction by-product is a hydrogen halide.

5. A method for growing a thin film on a substrate in a reaction space, comprising:

(a) providing a hydrated substrate;

(b) introducing a tungsten halide precursor, where the halide is not a fluorine, into the reaction space to the hydrated substrate to create a halide terminated substrate surface;

(c) introducing silicon precursor selected from $Si_nX_mY_kH_l$, where X and Y are halides, and n,m,k,l are integers, into the reaction space to the halide terminated substrate surface to create a hydride terminated substrate surface;

(d) introducing atomic hydrogen into the reaction space to create a hydrogen terminated substrate;

(d) repeating steps (b), (c) and (d) an integral number of times to form a metal silicide film on the substrate, wherein a reaction by-product is a hydrogen halide.

6. A method for growing a thin film on a substrate in a reaction space, comprising:

(a) providing a hydrated substrate;

(b) introducing a tungsten halide, where the halide is not fluorine, into the reaction space to the hydrated substrate to create a halide terminated substrate surface;

(c) introducing atomic hydrogen into the reaction space to the surface previously terminates with a halide

(d) introducing a silicon chloride precursor into the reaction space to the surface previously terminated with a halide; and

(e) repeating steps (c), (b), (c) and (d) an integral number of times to form a metal silicide film on the substrate, wherein a reaction by-product is a hydrogen halide.

7. A method for growing a thin film on a substrate in a reaction space, comprising:

(a) providing a hydrated substrate;

(b) introducing a tungsten halide, where the halide is not fluorine, into the reaction space to the hydrated substrate to create a halide terminated substrate surface;

(c) introducing atomic hydrogen into the reaction space to the surface previously terminated with a halide to create a hydrided surface;

(d) introducing a silicon chloride precursor into the reaction space to the hydrogen terminated substrate surface to create a halide terminated substrate surface;

(e) introducing atomic hydrogen into the reaction space to the surface previously terminated with a halide; and

(f) repeating steps (b), (c,) (d), and (e) an integral number of times to form a metal silicide film on the substrate, wherein a reaction by-product is a hydrogen halide.

8. A method for growing a thin film on a substrate in a reaction space, comprising:

(a) providing a hydrated substrate;

(b) introducing a first tungsten halide, where the halide is not fluorine, into the reaction space to the hydrated substrate to create a halide terminated substrate surface;

(c) introducing atomic hydrogen into the reaction space to the surface previously terminated with a halide;

(d) introducing a second tungsten halide, where the halide is not fluorine, into the reaction space to the hydrated substrate to create a halide terminated substrate surface;

(e) repeating steps (c) and (d) an integral number of times

(d) introducing a silicon hydride into the reaction space to the surface previously terminates with a halide; and

(e) repeating steps (b), (c) and (d) an integral number of times.

9. A method for growing a thin film on a substrate in a reaction space, comprising:

(a) providing a hydrated substrate;

(b) introducing a tungsten halide precursor, where the halide is not fluorine, into the reaction space to the hydrated substrate to create a halide terminated substrate surface;

(c) introducing Si hydride into the reaction space to the surface previously terminated with a halide;

(d) introducing Si halide into the reaction space to the surface previously terminates with a hydride;

(e) repeating (c) and (d) an integral number of times

(f) introducing Si hydride into the reaction space to the surface previously terminated with a halide; and

(g) repeating steps (b) through (f) an integral of number of times.

10. A method for growing a thin film on a substrate in a reaction space, comprising:

(a) providing a hydrated substrate;

(b) controllably depositing a metal silicide with an ALD process in a pre-determined number of ALD cycles to form a metal layer on the hydrated substrate;

(c) terminating the metal layer with a halide to form a surface halided metal layer;

(d) controllably depositing a tungsten layer using WCl_6 ALD chemistry with H reduction;

(e) repeating steps (b) (c) and (d) an integral number of times to form a nanolaminate of silicide and metal layers on the hydrated substrate.

11. A method for growing a thin film on a substrate in a reaction space, comprising:

(a) providing a hydrated substrate;

(b) controllably depositing a metal silicide with an ALD process in a pre-determined number of ALD cycles to form a metal layer on the hydrated substrate;

(c) terminating the metal layer with a halide to form a surface halided metal layer;

(d) controllably depositing additional tungsten layers using WF_6 ALD chemistry with silicon hydride reduction; and

(e) repeating steps (b) (c) and (d) an integral number of times to form a nanolaminate of silicide and metal layers on the hydrated substrate.

12. A method for growing a thin film on a substrate in a reaction space, comprising:

(a) providing a hydrated substrate;

(b) controllably depositing a metal halide with an ALD process in a pre-determined number of ALD cycles to form a metal layer on the hydrated substrate;

(c) introducing atomic hydrogen into the reaction space to the surface previously terminated with a halide to create a hydrided surface;

(d) controllably depositing silicon halide; and

(e) repeating steps (b) (c) and (d) an integral number of times to form a nanolaminate of silicide and metal layers on the hydrated substrate.

13. A method for growing a thin film on a substrate in a reaction space, comprising:

(a) providing a hydrated substrate;

(b) controllably depositing a metal halide with an ALD process in a pre-determined number of ALD cycles to form a metal layer on the hydrated substrate;

(c) introducing atomic hydrogen into the reaction space;

(c) introducing a silicon halide into the reaction space;

(d) introducing atomic hydrogen into the reaction space; and

(e) repeating steps (b) (c). (d) and (e) an integral number of times to form a nanolaminate of silicide and metal layers on the hydrated substrate.